

ELECTRONIC FUNDAMENTALS

SERVICE PRACTICES 20

SPECIAL TOOLS

- 20-1. Screwdrivers
- 20-2. Wrenches
- 20-3. Pliers
- 20-4. Tweezers
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RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION OF AMERICA

HOME STUDY SCHOOL

350 West 4th Street, New York 14, N. Y.

Service Practices 20

INTRODUCTION

You have already learned about the ordinary tools you will use most often in Service Practices 2. It would be difficult and sometimes impossible to repair a radio receiver without them. In this booklet, you will read about *special* tools. These are not used as often as the ordinary tools. They are used when an ordinary tool will not do the job or when a special tool will do the job faster.

Use this booklet to get acquainted with special tools. But before you buy any tools, be sure that you need them; when you buy, get tools of good quality; after you buy tools, treat them with care.

20-1. SCREWDRIVERS

The purpose of a screwdriver is to loosen or tighten screws. It should not be used for other purposes, such as stirring paint or opening cans. There are many special screwdrivers, some of a special size, some with a special shape, some with a special blade, and some with a special attachment.

The *stubby screwdriver* of Fig. 20-1 is handy for use in a tight space; it comes with either a standard or a Phillips blade.

The *offset screwdriver* (offset means bent) of Fig. 20-2 is also handy for tight spaces, and handy when leverage is needed to loosen a tight screw. It is somewhat difficult to use because the blade will jump out of the slot in the screw head if you are not careful. Offset screwdrivers are made with either standard or Phillips blades. Fig. 20-3 shows an offset screwdriver with a ratchet attachment; so it is possible to turn a screw completely around without turning the screwdriver handle all the way around. The

screwdriver turns the screw part of the way. Then, when you turn the handle *back*, the ratchet slips; the blade does not turn back with the handle. So, the screw remains in its new position. When you repeat the motion, the screw is turned part-way again. You continue with short twists until the screw is turned all the way in or out. The ratchet makes it possible to use the offset screwdriver in a space too tight for you to turn the handle all the way around, and you don't have to remove the blade from the screw slot to do it.

Straight screwdrivers are made with ratchet attachments, too. One of these is shown in Fig. 20-4. You do not have to turn such a screwdriver to drive a screw, nor do you have to turn the screwdriver to *unscrew*. The ratchet — called a *spiral ratchet* — makes the blade turn when you push the handle. A flick of the finger on the change-over lever changes the direction of rotation of the blade so that you can unscrew by pushing the handle. This kind is shown in Fig. 20-4. This screwdriver is for wood screws. Sometimes it has a hollow handle to hold extra blades.

The screwdriver shown in Fig. 20-5 has a flexible shaft; it can bend around corners.

The *jeweler's screwdrivers* shown in Fig. 20-6 have tiny blades that fit screws that no standard screwdriver blade would fit.

If you have ever used a screwdriver with a steel blade near a strong magnet, you know that it is hard to guide the blade into the screw slot. The magnet pulls the blade aside and interferes with your sense of balance. If the blade were made of copper or aluminum, the magnet would have no pulling effect. Unhappily, neither copper nor aluminum are usable for screwdriver blades; these soft metals bend too easily. But,

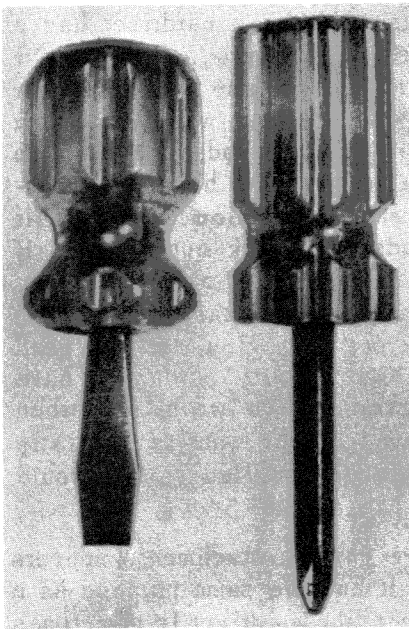


Fig. 20-1

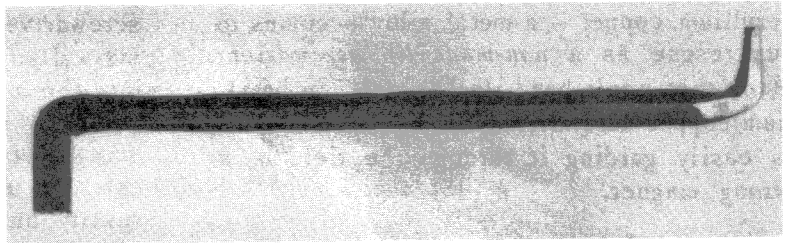


Fig. 20-2

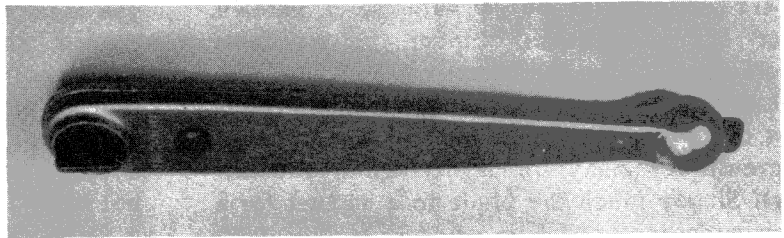


Fig. 20-3

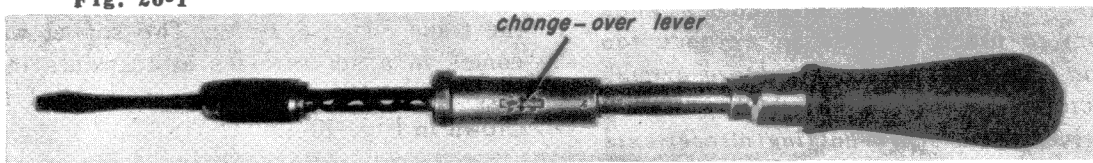


Fig. 20-4

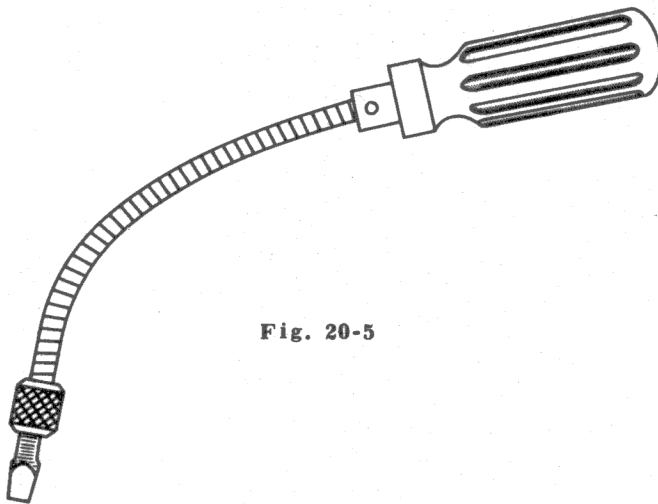


Fig. 20-5

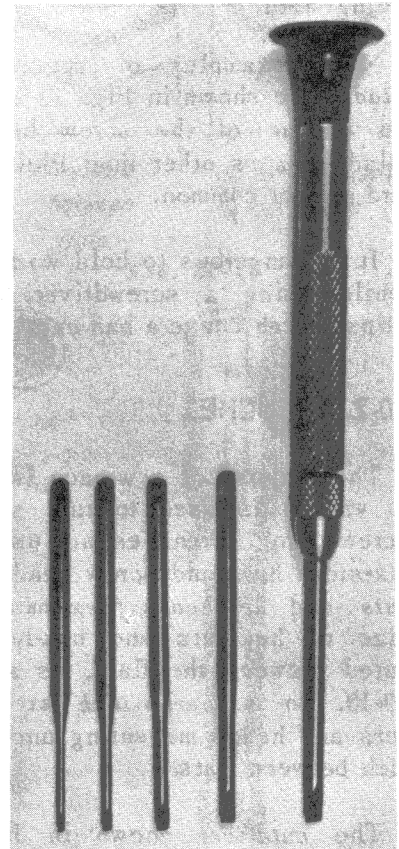


Fig. 20-6

beryllium copper — a metal alloy — comes to our rescue as a *non-magnetic screwdriver* blade that won't bend. In Fig. 20-7, a beryllium copper screwdriver is at work — a hand is easily guiding it through the field of a strong magnet.

Some servicemen *magnetize* a screwdriver blade so that it will pick up and hold screws. This screwdriver works with steel screws, but not with brass, copper, or aluminum screws. It has the disadvantage that the blade will pick up things not wanted as well as things wanted. It is easy to magnetize a screwdriver (many are magnetized accidentally). Simply touch the blade to a magnet for a few minutes.

Did you ever try to balance a screw on the end of a screwdriver that was *not* magnetized? The urge to do this comes when you want to place a screw in a space too tight for your hand to fit, but large enough for a screwdriver blade to fit. In Fig. 20-8a, screwdrivers with *screw-holding attachments* are shown. Fig. 20-8b shows the screws being held.

Two examples of special screwdriver *blades* are shown in Fig. 20-9, together with an outline of the screw heads they fit. Blade shapes other than Philips and Standard are not common.

It is dangerous to hold work in your hand while using a screwdriver. If the blade slips, it can cause a bad cut.

20-2. WRENCHES

The purpose of a wrench is to turn nuts. A wrench is used to turn some kinds of screws, too. Wrenches are used mainly for six-sided nuts and screw heads, called *hex-nuts* and *hex-heads* (*hex* means six). The size of hex-nuts and hex-heads is measured between the flats, as shown in Fig. 20-10. So a *quarter-inch* wrench fits hex-nuts and heads measuring one-quarter of an inch between flats.

The *nutdriver* shown in Fig. 20-11, a wrench popular for radio work, is built like a screwdriver. The difference is that where a

screwdriver has a blade, a nutdriver has a six-walled socket. Hex-nuts and heads fit into the socket. You can use a nutdriver for hex-head screws the same way you use a screwdriver for slotted-head screws. You can also use a nutdriver for hex nuts. Good-quality nutdrivers have hollow shafts to fit over screw-studs that stick out of nuts. If you use a nutdriver without a hollow shaft, you won't be able to make the socket reach the nut as the nut goes closer to the head of the screw. Good-quality nutdrivers have thin-walled sockets, which are helpful when the nut or screw-head you want to turn is in a place where a thick-walled socket would not fit.

A *socket wrench* and attachments appears in Fig. 20-12. It has the same purpose as a nutdriver. In fact, the nutdriver is sometimes called socket wrench and is also called by the trade name, *Spintite*. The socket wrench comes in a set with its attachments including, *some* though usually not *all*, of those shown in Fig. 20-12.

There are different kinds of handles. Different sockets may be attached to any handle. You can connect sockets to the screwdriver-type handle in Fig. 20-12a to make a nutdriver; it does not have the advantage of a hollow shaft. A special socket — long and hollow — makes up for this, but usually it isn't part of a standard set. One of these is shown in Fig. 20-12b. The extension shaft (20-12c) can be used with the handle in a to make a longer nutdriver. It can also be used with the ratchet-handle (20-12d) and the T-handle (20-12e). The swivel-handle (20-12f) has a socket that makes it possible to hold it either at an angle for leverage or straight as a nutdriver. Two kinds of socket opening are shown in Fig. 20-13. Either kind fits the hex nut. The twelve-point socket grasps only the points of the nut. Every second point of the twelve points of the socket lines up with one of the six points of the nut. The modern twelve-point socket is easier to set in place on a nut.

Wrench sockets are small and easy to lose so, be careful.

The holding kind of nutdriver shown in Fig. 20-14 — a cousin to the holding kind of

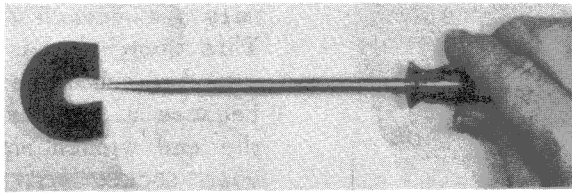


Fig. 20-7

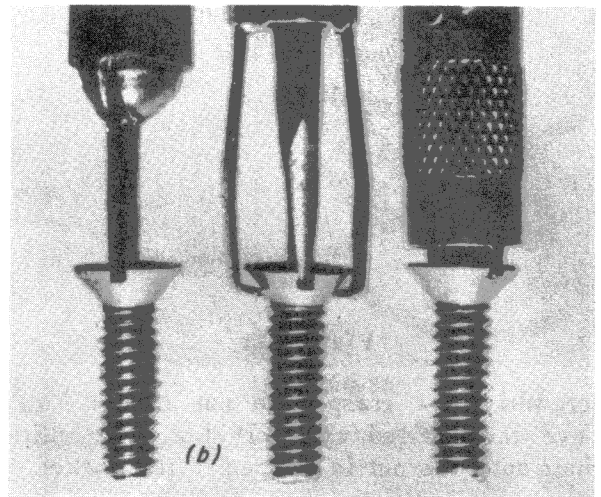
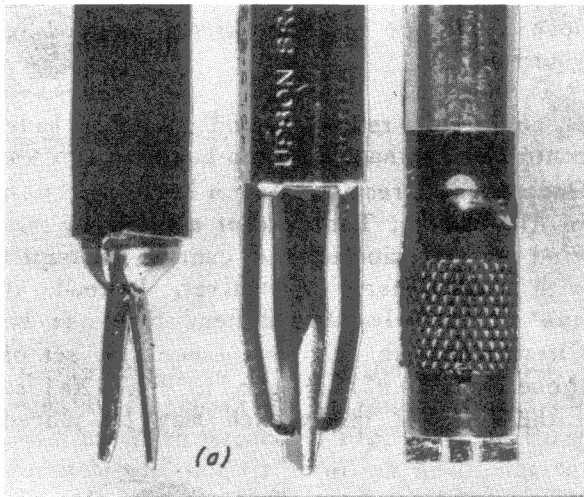


Fig. 20-8

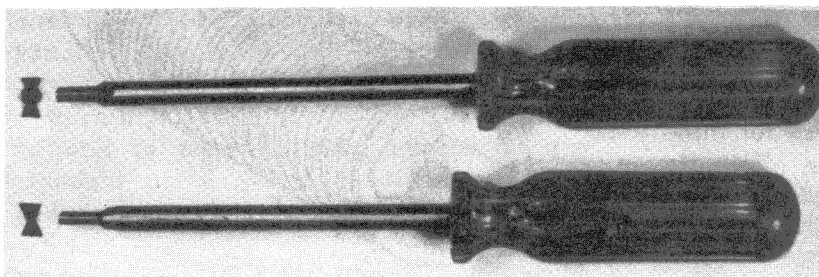


Fig. 20-9

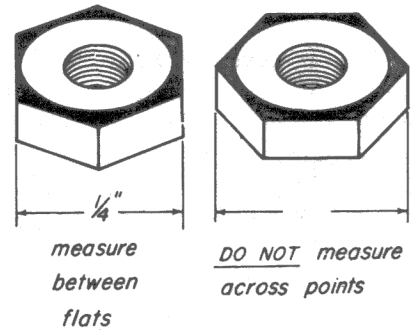


Fig. 20-10

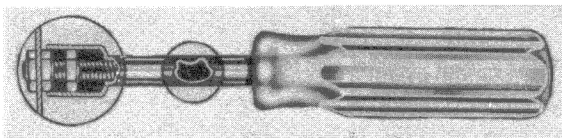


Fig. 20-11

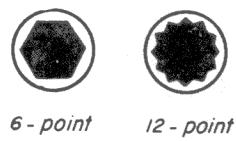


Fig. 20-13

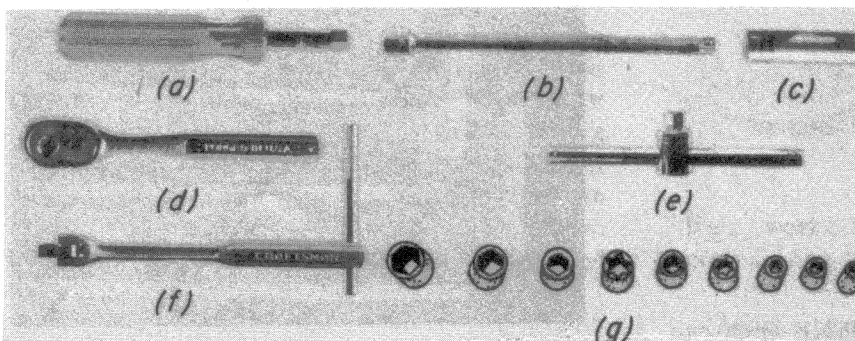


Fig. 20-12



Fig. 20-14

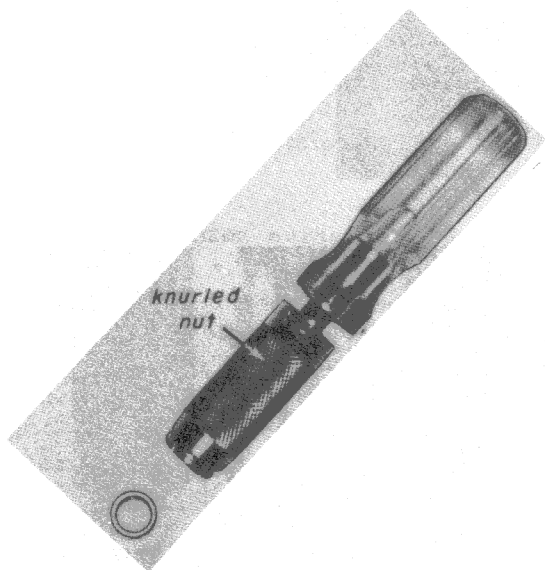


Fig. 20-15

screwdriver — grasps the nut firmly: You move the knurled cylinder along the split shaft until the nut is gripped in the socket.

The nutdriver of Fig. 20-15 is for knurled nuts. It works like the holding kind of driver but has a smooth, round socket instead of a hex-socket. It is better than pliers for turning knurled nuts because, unlike pliers, it has no teeth to dig into the nut.

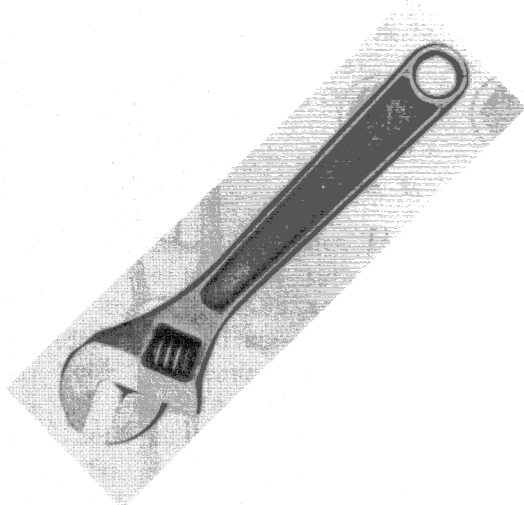
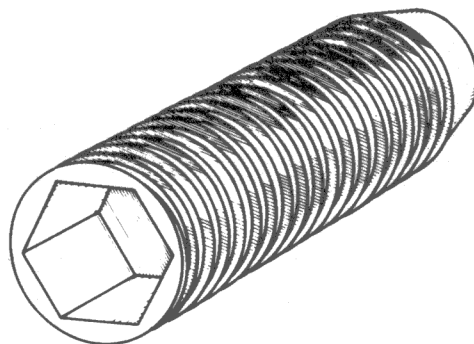


Fig. 20-16

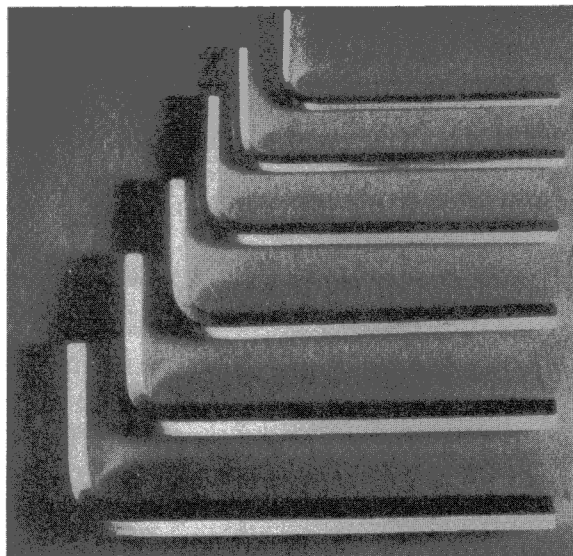
Fig. 20-16 shows an *adjustable open-end wrench*. Although fixed-size open-end wrenches are available, the adjustable kind per-

mits the wrench to fit several nut sizes. This wrench is handy where you want leverage, but can't use an offset socket wrench because a screw stud is in the way. Also, the end wrench may fit nuts too large for your socket set. To avoid banging your knuckles, pull on the wrench — do not push. If you must push, do so with the palm of your open hand, not with the wrench gripped in your fist.

Some radio receivers and TV sets have control knobs that use Allen-head set screws. One of these, removed from a knob, is shown in Fig. 20-17a. The head of a screw of this kind is not slotted and cannot be turned with an ordinary screwdriver. Instead, it has a specially shaped head that can be fitted only with an *Allen wrench*. A set of these wrenches is shown in Fig. 20-17b. Either end of the wrench may be placed



(a)



(b)

Fig. 20-17

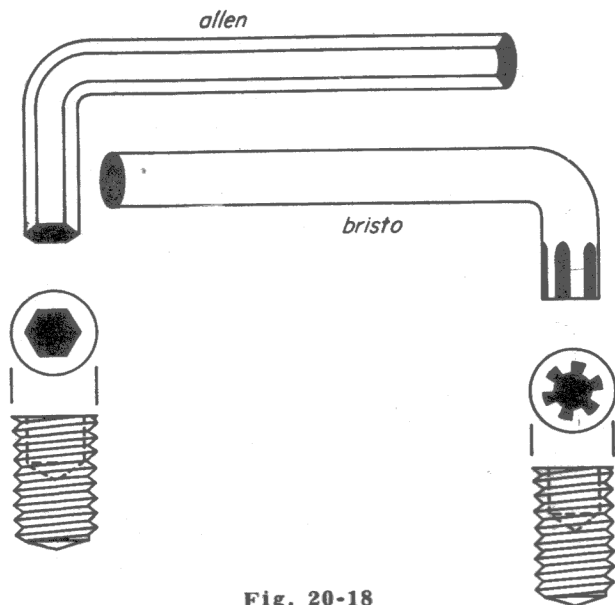


Fig. 20-18

within the head of the Allen set screw. A similar wrench is the *Bristow*, shown together with an Allen wrench in Fig. 20-18. A Bristow wrench will not fit an Allen head, nor will an Allen wrench fit a Bristow head. Fig. 20-19 shows a handle for Bristow and Allen wrenches. The wrenches used with this handle are straight – not L-shaped.

When using wrenches or screwdrivers, it is well to remember that, except for non-standard threads, turning clockwise tightens and turning counterclockwise loosens.

20-3. PLIERS

The main purpose of a serviceman's pliers is to work with wire – to hold wire, to bend wire, and to cut wire. It's better not to use a light-duty pliers to turn nuts and screws – better for the pliers and better for the nuts.

The *long-nose pliers* is stock in trade to a serviceman. Helpmate to the regular long-nose pliers is the *needle-nose pliers* of Fig. 20-20. Two sizes are shown; the narrow size fits tight spaces but the jaws spring aside when twisted to bend wire. The other size has wider jaws; yet, it is narrower than the regular long-nose pliers. Its jaws have enough body not to spring aside when used to bend wire.

The pliers of Fig. 20-21 is a small-scale copy of the regular long-nose and is used for

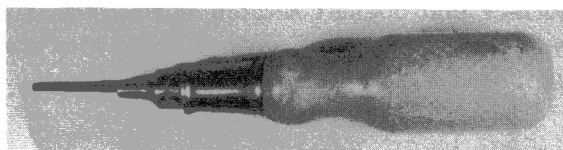


Fig. 20-19

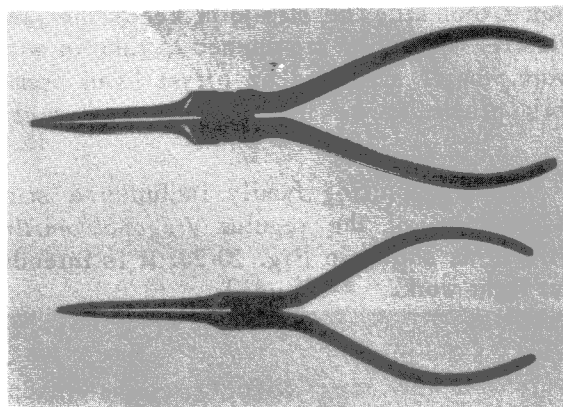


Fig. 20-20

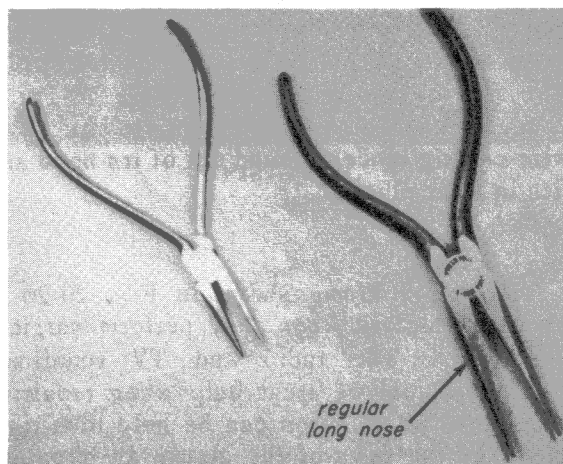


Fig. 20-21

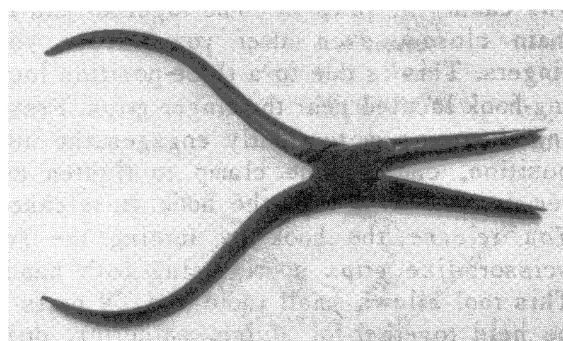


Fig. 20-22

light work. It serves the serviceman as a companion tool to the regular long nose.

Another member of the long-nose family is the toothless *duck-bill pliers* of Fig. 20-22. Its special features are a smooth gripping

surface that doesn't scratch and a tip that is wide enough to hold several wires for twisting.

Ignition pliers, like the pair shown in Fig. 20-23, make a useful addition to a serviceman's tool kit. The slip-joint keeps the jaws parallel when they are opened to take in wide work. Small size and an offset head permit this pliers to be used in close quarters.

The wire-cutting family includes a small scale-copy of the regular *diagonal cutting pliers*, as shown in Fig. 20-24. It is intended for light work.

If you have ever tried to use a diagonal pliers to cut one wire out of a tight grouping of wires, you know that the blunt nose of the pliers gets in the way. It does not fit between wires to single out the one you'd like to snip. The cutting pliers shown in Fig. 20-25 is shaped like a long-nose pliers. It has small wire-cutting blades ground out of its nose and fits in tight places.

The *suture clamp* shown in Fig. 20-26 is used by doctors when they perform surgical operations. The radio and TV repairman finds this tool of great help when repairing receivers. Small wires can be held in a tight grasp by the jaws of the clamp. By pressing the two scissors-like finger-grips together, you cause the jaws to come together and remain closed, even after you release your fingers. This is due to a three-position locking-hook located near the finger-grips. Pressing the grips more tightly engages the next position, causing the clamp to tighten and remain this way until the hook is released. You release the hook by forcing the two scissors-like grips apart, using both hands. This tool allows small radio and TV parts to be held together for gluing, soldering, drilling, filing, etc.

20-4. TWEEZERS

A close relative to the pliers is the tweezers. Three kinds are pictured in Fig. 20-27. The

one at (a) is *normally opened*; to close it, you squeeze. The one at (b) is *normally closed*; when you squeeze this one, it opens. Tweezers are not strong enough to twist wire. They are useful for starting screws and nuts in difficult places; holding wires and small parts together when soldering; clamping cemented pieces together; installing dial cord and record-changer springs; and looping and untying knots on dial-drive cords. The plastic tweezers in Fig. 20-27c can be used to move wires and small parts while you troubleshoot a chassis with power applied.

When a small article such as a piece of wire or a screw has fallen into a chassis and cannot be reached with the tweezers, the *pickup tool* shown in Fig. 20-28 may be used. This not only comes in handy for picking up objects but can also be used to place a screw in a hard-to-get-to hole and hold it there while threading the nut into it with the other hand. A finger operated push-and-release device, located at the handle end of the tool, allows the object to be held and released.

20-5. SAWS

To mount a loudspeaker on a wooden baffle board, a large hole must be cut in the board; the size of the hole depends upon the size of the speaker used. The *keyhole saw*, shown in Fig. 20-29a, is often used for this purpose. First, draw a circle with a diameter 1/2-inch less than the finished diameter (use a pencil on the wood surface). Then, drill holes on the line of the circle as shown in Fig. 20-29b. Use a 1/2-inch drill. Next, the keyhole saw is used. Cut past the outer edge of each 1/2-inch hole and completely around the circle.

This saw uses removable blades and has a pistol grip handle. Unlike a carpenter's keyhole saw, the kind servicemen use cuts *metal* (control shafts, chassis, etc). It has an advantage over the ordinary hack saw; the blade tip can be inserted through drilled holes, and then cuts can be made in the manner described for woodworking.

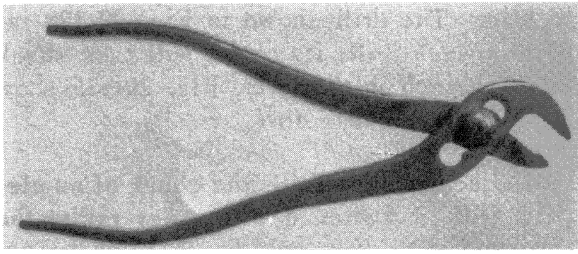


Fig. 20-23

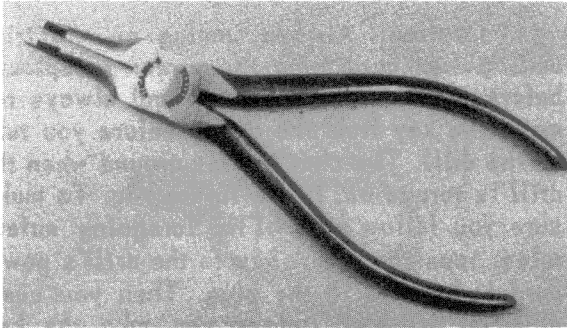


Fig. 20-25

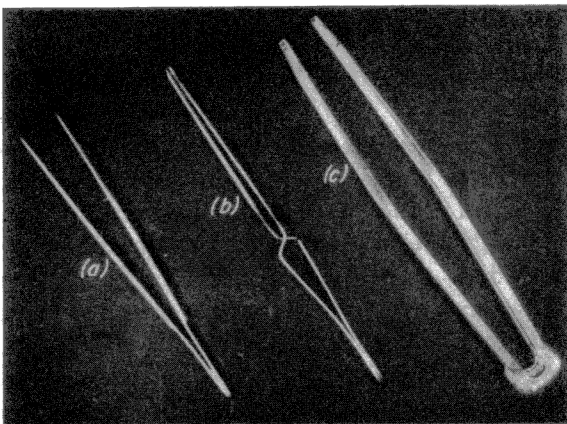


Fig. 20-27

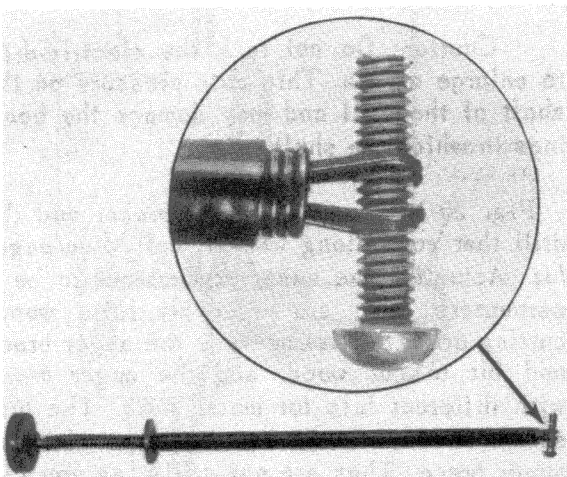


Fig. 20-28

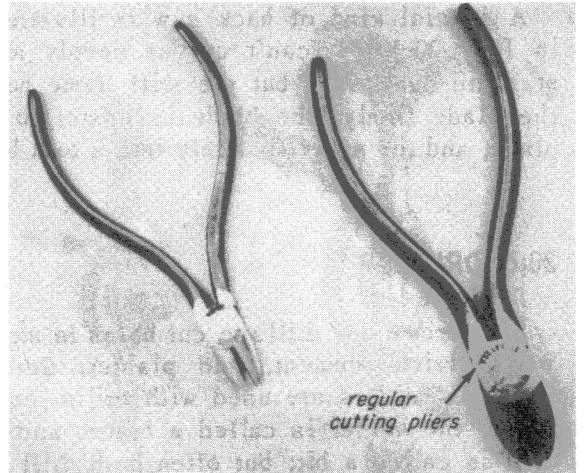


Fig. 20-24

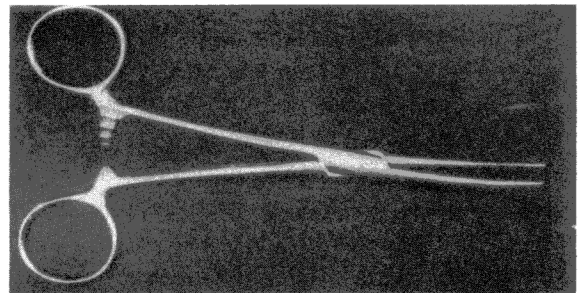
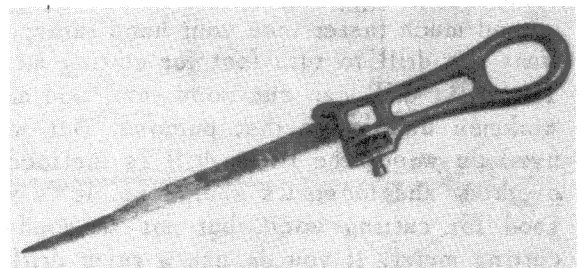
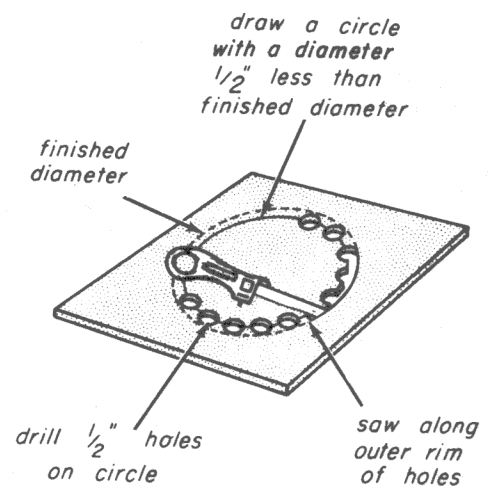


Fig. 20-26



(a)



(b)

Fig. 20-29

A special kind of hack saw is illustrated in Fig. 20-30. It can't cut as deeply as a standard hack saw, but the stiff frame holds the blade firmly; the blade is easier to replace, and the saw fits nicely into a tool box.

20-6. DRILLS

Servicemen use drills to cut holes in metal, wood, brick, cement, and plaster. Several kinds of holders are used with drills. Sometimes, the holder is called a brace, and the drill is called a bit; but often both drill and holder are referred to as a drill.

The hand-drill is shown in Fig. 20-31a has a nickname — *egg-beater*. It works just like an egg-beater. The egg-beater holds a *twist drill*. The hand-drill shown in Fig. 20-31b — called a *breast drill* — will take a somewhat larger twist drill. You can do heavier work with the breast drill. A twist drill is shown alone in Fig. 20-31c. Twist drills are made for cutting metal. When you turn the crank of the egg-beater, the twist drill goes around much faster than your hand turns; you want the drill to turn fast for cutting metal. The twist drill can cut wood, too, and many workmen use it for that purpose. But when used on wood, the twist drill is inclined to overheat and lose its sharpness. It is still good for cutting wood, but not so good for cutting metal. If you *do* use a twist drill on wood, turn it slowly.

The *chuck* is the part of the egg-beater that grasps the twist drill. The part of the twist drill that goes into the chuck is called the *shank*. Twist drills usually have straight shanks; the one shown in Fig. 20-31c has a straight shank. Only drills with straight shanks fit into the chuck of the egg-beater. The largest drill you can fit into the chuck of the egg-beater shown in Fig. 20-31 is a $\frac{1}{4}$ -inch in diameter.

Like the hand-drills, the *electric drills* shown in Fig. 20-32a and b have chucks made to hold straight-shank drills. Twist drills usually are used with electric drills, although other kinds can be used, too — for example, a carbide-tipped drill used to drill

a brick. The drill shown in Fig. 20-32a is a *quarter-inch drill*; its chuck will take shanks up to $\frac{1}{4}$ -inch in diameter. Fig. 20-32b shows a *half-inch electric drill*.

Unlike the hand drill, the chuck of an electric drill is tightened with a *key* rather than by hand. The key may be an Allen wrench, or it may be the type shown in Fig. 20-33.

Caution: Always unplug an electric-drill power cord from the power receptacle before you handle the chuck and always remove the key from the chuck before you turn on the drill. The chuck spins around when the drill is turned on. It can injure you. To make sure you follow both of the foregoing safety rules, tape the chuck key to the drill's power cord right next to the plug. Then you can't plug in the plug unless you take the key out of the chuck. And you won't lose the key.

Quarter-inch electric drills run at speeds as high as 2,500 revolutions per minute, which is fast enough to overheat a twist drill that has not been oiled or a twist drill used on wood. Half-inch electric drills are made to run at about 400 rpm because a slow speed is more suitable for the heavy work they have to do. It is usually best not to use a $\frac{1}{2}$ -inch twist drill in a speedy quarter-inch electric drill. You may wonder how a $\frac{1}{2}$ -inch twist drill fits into a $\frac{1}{4}$ -inch chuck. You can buy $\frac{1}{2}$ -inch twist drills that have $\frac{1}{4}$ -inch shanks. But these are made for light drilling in soft material.

Caution: Do not rock the electric-drill to enlarge a hole. This puts pressure on the shaft of the drill and may damage the bearings in which the shaft spins.

Fig. 20-34 shows an *auger brace*, and the drill that goes along with it, called an *auger bit*. Actually, the auger started out to be a carpenter's tool; an auger bit is a wood-cutting drill. Servicemen use the auger brace and bit to cut wood, and the auger brace with different bits for metal work. The bits shown in Fig. 20-35 can be used with the auger brace. They are not drills, as you can see. The bit in *a* is a screwdriver, *b* is a reamer, and *c* is a circle-cutting tool. Use

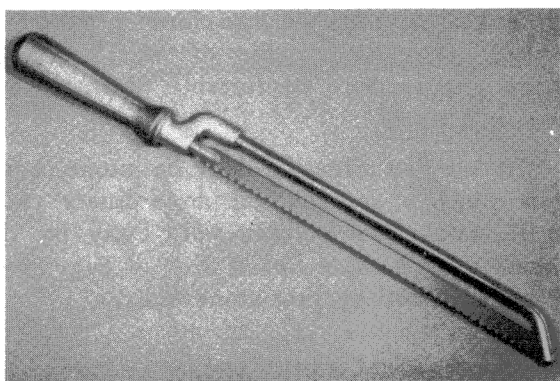
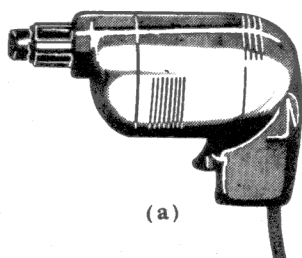
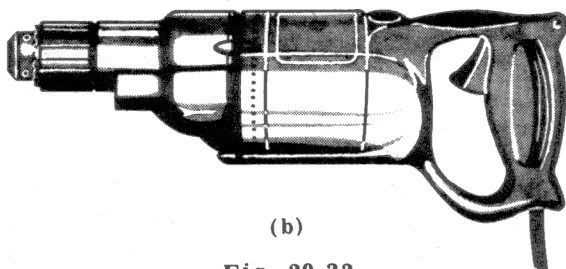


Fig. 20-30



(a)



(b)

Fig. 20-32

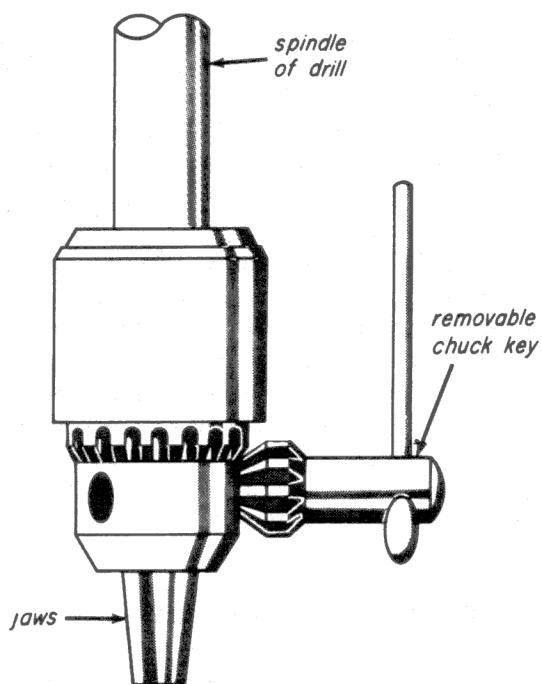
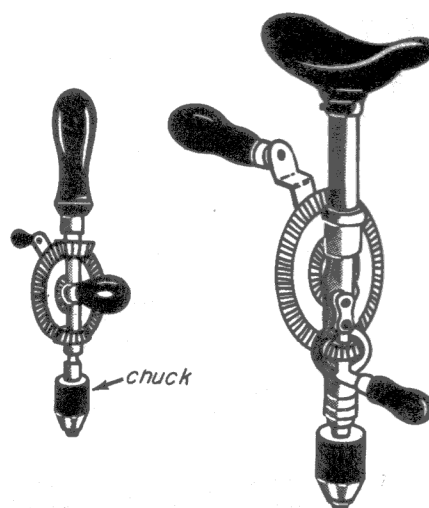
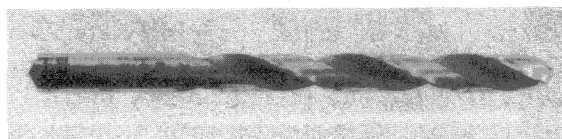


Fig. 20-33



(a)

(b)



(c)

Fig. 20-31

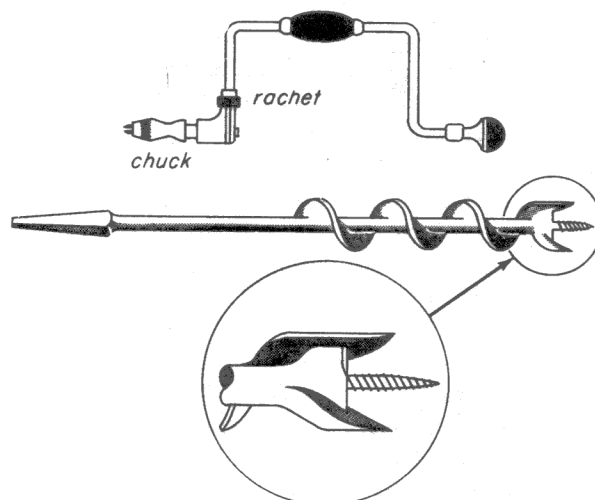
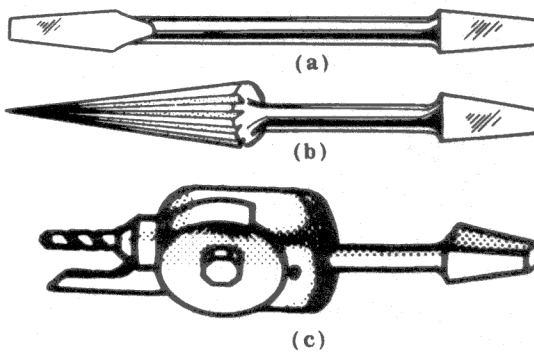


Fig. 20-34



(a)

(b)

(c)

Fig. 20-35

the auger brace with tools that have to be turned slowly; it is really a heavy-duty handle used with many kinds of tools. Some auger braces have ratchets like those on offset screwdrivers and socket wrenches.

The auger-drill chuck is not the same as the electric-drill chuck or the egg-beater chuck. It has to be different to hold a shank of the kind shown in Fig. 20-34 and 20-35. Auger bits will not fit into chucks designed for straight shanks, although you can easily make them fit by sawing the shank. Auger wood-drills with straight shanks are manufactured. They are for use with electric drills — the slow-turning half-inch electric drills.

Many kinds of auger wood-drills are available. Servicemen are fond of expansion drills like the one in Fig. 20-36, which can be set to any diameter between 3/8-inch and one inch.

Fig. 20-37 shows an extension shaft for auger bits used by electricians to drill through floors of a building, etc. Servicemen use it, once in a while, to drill holes for antenna lead-in wires. Its chuck will hold an auger shank, but not a straight shank. The diameter of the chuck is no larger than the diameter of the drill it is designed to hold, so the chuck will fit through the hole made by the drill.

The *push-drill* shown in Fig. 20-38 works like a spiral-ratchet screwdriver; you push, and the shaft turns. It uses fluted drills (shown in Fig. 20-38). This is a wood-drilling tool. No tool is better for making wood-screw pilot holes.

You use the drills shown in Fig. 20-38 for drilling — by hand — into brick, cement, or plaster. Fig. 20-39a, is a *rawl drill*; Fig. 20-39b is a *star drill*. To make a hole with either of these, you hold the point against the stonework to be drilled — grasping the drill in your fist — and you strike the flat end of the drill with a hammer at the same time that you twist the drill. Naturally, your hand is in danger of getting hit. The attachment that will save it is shown in Fig. 20-40. It's a rubber hand-grip that fits over the

drill and spreads out, to form a shield to cover the exposed side of your fist. The hand grip is more comfortable to grasp than the drill itself.

To use an electric drill on stone work, you need a special bit; an ordinary twist drill would be quickly worn away by the stone. The *carbide-tipped drill* of Fig. 20-41 stands up well against stonework.

20-7. REAMERS AND TAPS

Reamers and taps are tools that can be used in a hole after it has been drilled. These tools are for metal-work. The reamer enlarges a hole; the tap threads it to take a screw. Two reamers are shown in Fig. 20-42. You can make a bigger hole with *a*, but you can fit *b* into a hole that is smaller to begin with. Reamers come with screwdriver handles and T-handles, and with an auger-bit shank. Taps (Fig. 20-43) come with T-handles, have to be oiled in use, and have to be screwed *slowly* into a hole and backed up now and again, to avoid binding. Tap sizes are the same as screw sizes. A 4-40 tap threads a hole to receive a 4-40 screw. The 4 in this number stands for a screw of a certain thickness; 40 stands for 40 threads per inch. In radio receivers, 4-40, 6-32, and 8-32 screws are frequently found.

The screw extractor kit of Fig. 20-44 is not needed often. When it is needed, nothing can take its place. You use it to remove a screw that is stuck — for example, a screw that is so rusted it will not turn. In trying to turn it, let us say you damaged the slot; so there is no way to grip it. What you do is drill a hole in the screw; choose an extractor to fit the hole; and thread it in. Now, the extractor threads *in* from right to left, the opposite of standard screws. As you tighten the extractor, you loosen the screw. Of course, the leverage you can apply with the T-handle is more than you could apply with a screwdriver to a screw slot without breaking the walls of the slot.

20-8. MISCELLANEOUS TOOLS

It is possible to remove the insulation from the ends of wires in many ways. You

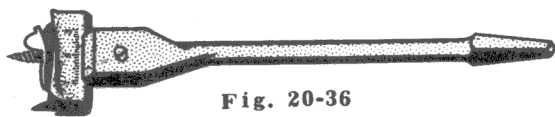


Fig. 20-36

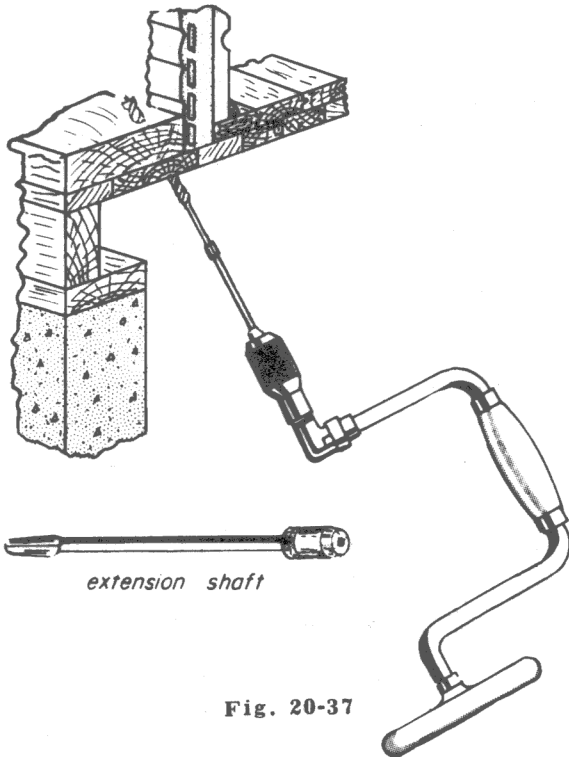


Fig. 20-37

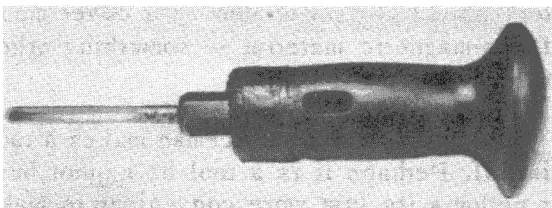


Fig. 20-40

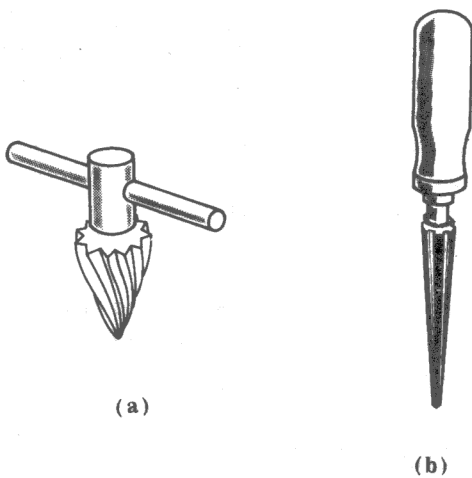


Fig. 20-42

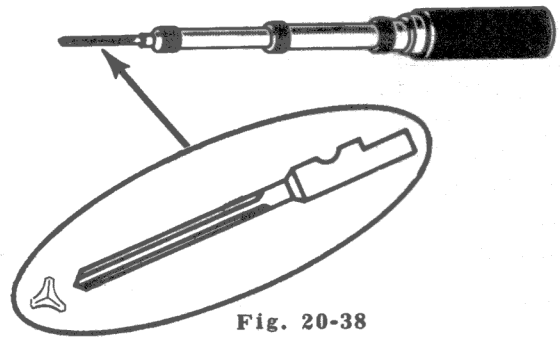
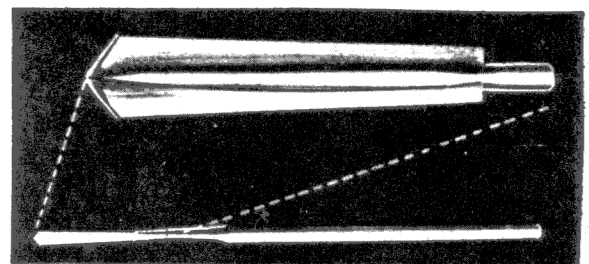


Fig. 20-38



(a)



(b)

Fig. 20-39

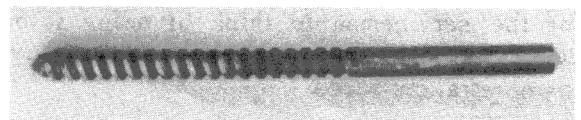


Fig. 20-41

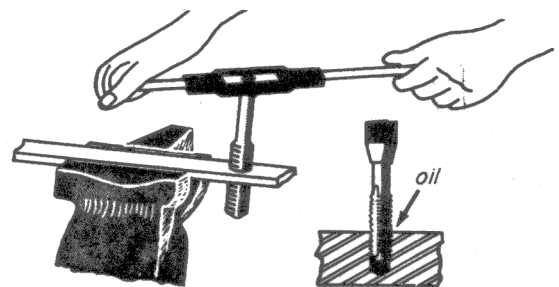


Fig. 20-43

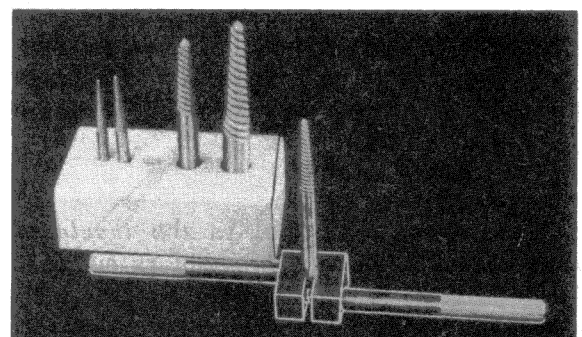


Fig. 20-44

can cut it off with a knife blade, with cutting pliers, etc. But a quicker and cleaner method is to use a *wire stripper*. Two types are shown in Figs. 20-45a and b. The first type (shown in Fig. 20-45a) is the simpler of the two. To use it, you place the end of the lead into the cutting groove of the stripper; you hold the wire in one hand, the stripper in the other hand; and you pull downwards, away from the cutting edges of the groove. The second type (shown in Fig. 20-45b) costs more; it does a clean job that looks like it was done at the factory. With this type of wire cutter, you must get the wire into the right groove, to avoid cutting the end off the copper wire instead of stripping the insulation.

In his need for a good wire stripper to use on braided cables like the coaxial cable of Fig. 20-45c, the serviceman has borrowed the plumbers pipe-cutting tool shown in Fig. 20-45d. The plumber doesn't use this small-sized pipe cutter on heavy iron pipes, but on soft copper tubes. So it was natural for the serviceman to think of using it on copper braid. It cuts the braid evenly, leaving no straggly wires.

The *awl* (shown in Fig. 20-46a) is much like an ice pick, except that it is shorter. You use it to dig solder out of the hole in a lug so you can put a wire through. Recently, a tool purposely designed to be a soldering aid has come into use. It is the *soldering aid*. As you can see in Fig. 20-46b, the prong at one end of the handle has a pointed scoop-like shaft shaped for digging in solder. The other prong is forked for twisting or untwisting wire. The prongs are made of a metal alloy that cannot be soldered; you can work the tool in hot solder and none will stick. The metal alloy is hard, so you can use the tool to enlarge small screw-holes in sheet metal by reaming them out with the scoop prong.

Another prong-like tool is the *insulated probe* of Fig. 20-46c. This tool is made of plastic. Unlike the soldering aid or the awl, it does not conduct electricity. You use it to probe the wiring of a chassis with power applied.

The *alcohol torch* shown in Fig. 20-47 is used to heat metal for soldering. It is specially useful where the area to be heated is large, and also where no electric power can be had to heat a soldering iron.

The *spirit level* (Fig. 20-48) shows when you have something situated exactly level across or when you have it straight up-and-down. A serviceman needs a level to get a record-player motor board exactly level and to make sure that a pole for an antenna is straight up and down.

The *steel tape-measure* of Fig. 20-49 is a well known tool – almost a household necessity. It has its place in the serviceman's tool box.

The tool in Fig. 20-50 is simply a small, balanced bar-magnet. The bar will turn to point at any metal object that the tool comes near. You can use it to locate a nail where the nail (in a wall) is invisible because it is covered with paint. Once you have found the nail, you know the location of a wooden beam or post. So the tool is a *beam-finder* or *post finder*. It can be used to find any iron or steel object that is hidden by a cover made of non-magnetic material – something other than iron or steel.

Once in a while a serviceman makes a tool himself. Perhaps it is a tool he cannot buy, or perhaps its just more convenient to make the tool than to buy it. Fig. 20-51 shows part of a manufacturer's data sheet (for an RCA record player) giving instructions on how to make a special tool for a type of screw used on a phonograph for children.

The insulated probe (mentioned earlier) is a tool many servicemen make themselves, out of odd scraps of bakelite or other plastic material.

Sometimes it is convenient to make a wooden hacksaw blade handle like the one shown in Fig. 20-52.

20-9. ALIGNMENT TOOLS

Alignment screwdrivers (Fig. 20-53) must have as little metal in them as possible.

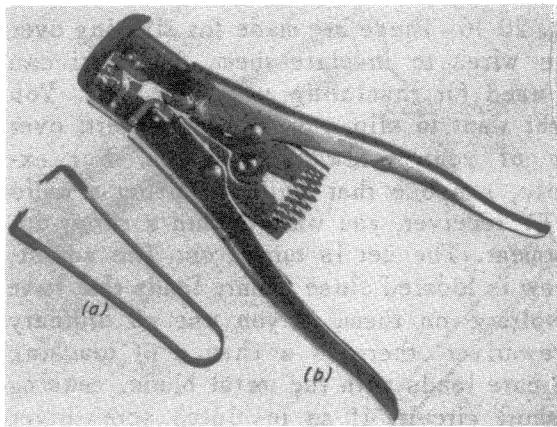


Fig. 20-45

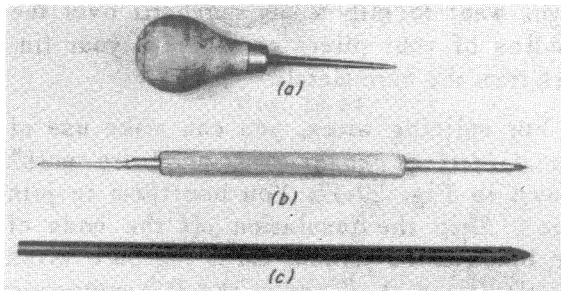
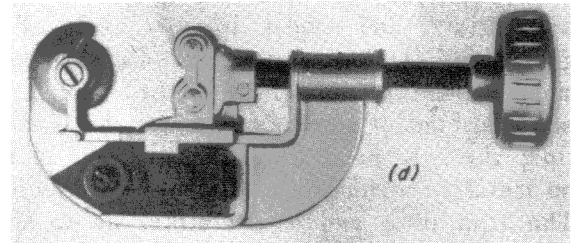
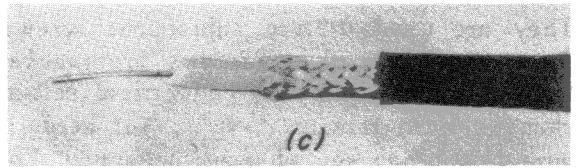


Fig. 20-48

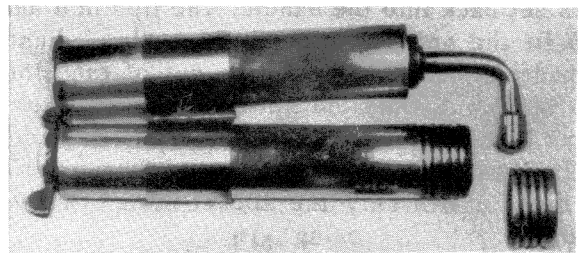


Fig. 20-47

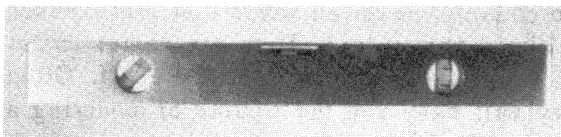


Fig. 20-48

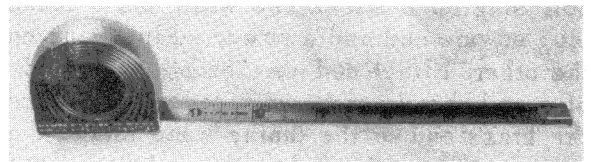


Fig. 20-49

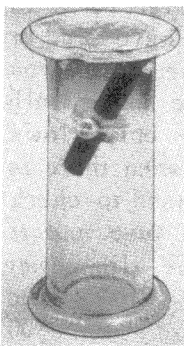


Fig. 20-50

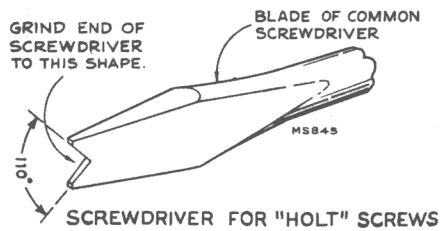


Fig. 20-51

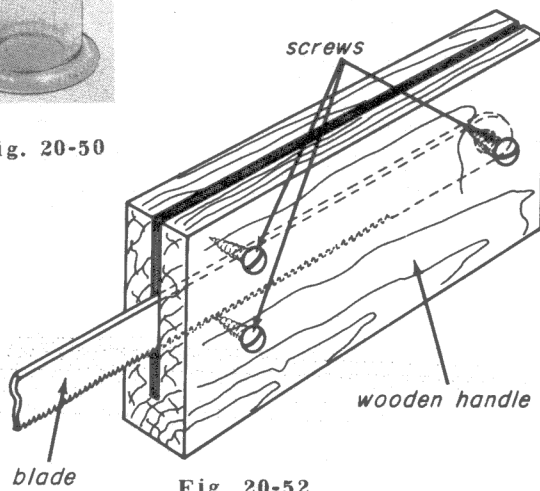


Fig. 20-52

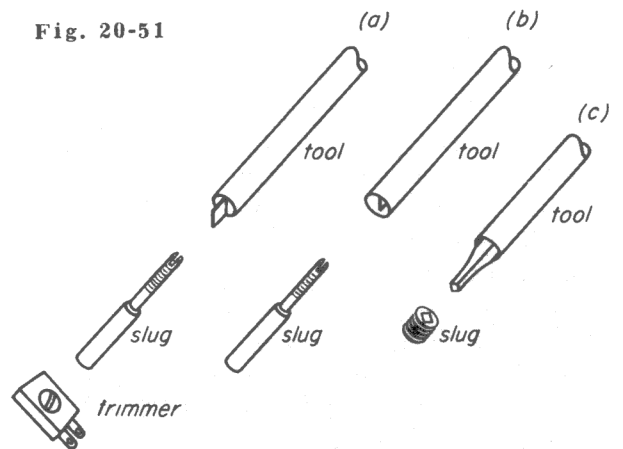


Fig. 20-53

They are used to turn adjustment screws. When radio-adjustment screws are *touched* by metal of any kind, their electrical setting changes even though they are *not* actually *turned*. You can see what might happen. You set the adjustment just right, remove the screwdriver, and Oops! it's *off* again. To get around this, alignment screwdrivers are made as shown in Fig. 20-53. In *a* and *b*, a small amount of metal is used for the blade-tips; the rest of the tools is plastic. In *c*, no metal is used; the entire tool is plastic. The tips in *a* and *b* are alike, as to the amount of metal they contain. But at *a*, the little blade sticks out of the handle; at *b*, it is set back into the handle. The tips in *a* and *b* fit the ordinary slotted-screw slug adjustment; although *a* may slide out of the slot, *b* stays put. Only the tip in *a*, with its stuck-out blade, can fit into the slot in the wide, flat head of the trimmer-screw. The plastic tip in *c* fits only the socket-head threaded slug.

The tuning wand in Fig. 20-54*a* is simply a coil slug on a stick. The wand has a brass slug on one end and a powdered-iron slug on the other. Either end can be slipped inside of a coil that is to be adjusted. If you place the brass end of the tuning wand inside the coil, it lowers the inductance; if you place the iron-core end inside the coil, it increases the inductance. The tuning changes as if by magic. Apparently the name *tuning wand* comes from *magic wand*. The *loop stick* (Fig. 20-54*b*) is another temporary tuning tool. It's a one-turn coil on a stick.

20-10. GADGETS

You're certain to find a roll of *tape* in the serviceman's tool box. It used to be friction tape (sticky cloth), or maybe rubber tape. Today it is *vinyl plastic tape*, which is something like ordinary transparent mending tape — the kind you don't have to lick. This tape is usually black instead of transparent, and stretchy instead of stiff. Vinyl tape (Fig. 20-55) is smooth on one side. After using it, you have a smooth surface, not a sticky surface that collects dirt. It is thin with excellent insulating quality. It doesn't make a big bulge.

You will agree that *spaghetti* is a suitable name for the insulating tubes shown in

Fig. 20-56. These are made for slipping over bare wires to insulate them. Spaghetti can be used for insulating *tools* as well. You might want to slip a piece of spaghetti over one of your screwdriver blades. For example, suppose that while repairing a radio or TV receiver, you want to turn a screw adjustment. The set is turned on. The adjust-screw is located close to bare leads that have a voltage on them. If you use an ordinary screwdriver, there is a chance of touching the bare leads with the metal blade, causing a short circuit; if an insulated screwdriver is used, it does not matter if the bare leads are touched. To take another example, you might want to slip some spaghetti over the handles of your pliers to insulate your fingers from the bare metal.

For splicing wires, you can make use of the *solderless connectors* or "wire nuts" shown in Fig. 20-57. You use them to join wires. Strip the insulation off the ends of the leads to be joined, twist the bare wires together, and then screw the DB connector over the twist. These can be used only *under* the chassis, never on wires that are exposed — like a power cord. They are easier to put on than tape and easier to take off. Often they will save you the trouble of mounting a terminal lug.

The *neon tester* shown in Fig. 20-58 is used to find out whether you have a.c. or d.c. at a wall outlet and whether or not you have voltage there at all. The whole bulb glows red for a.c.; one side only glows red for d.c. There is *no* glow when there is no voltage. The tester is also used to check fuses. If you put it across a fuse *and it glows*, the fuse is opened (done with power applied, of course). The tester can be used with voltages between 90 volts and 500 volts. You can make one using the neon bulb that came with your kit. Connect a 100,000-ohm resistor in series with one of the bulb leads.

A *tube puller* (Fig. 20-59) is used to pull a hot tube without waiting for it to cool down. The puller holds on to the tube by suction. To use it, you push the button, seat the puller on the tube, release the button, and pull the tube. The *pin straightener* (Fig. 20-60) is used to straighten tube pins if the pins have been bent.

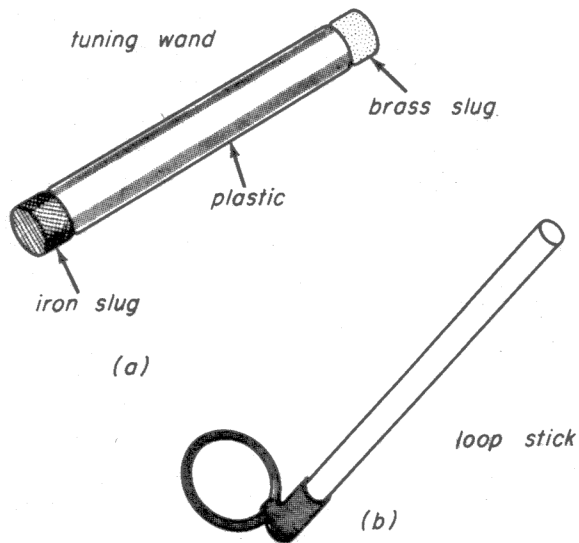


Fig. 20-54

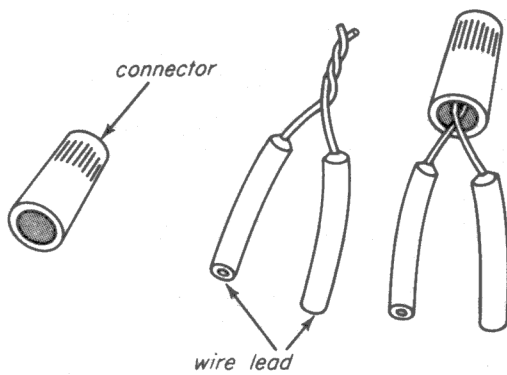


Fig. 20-57

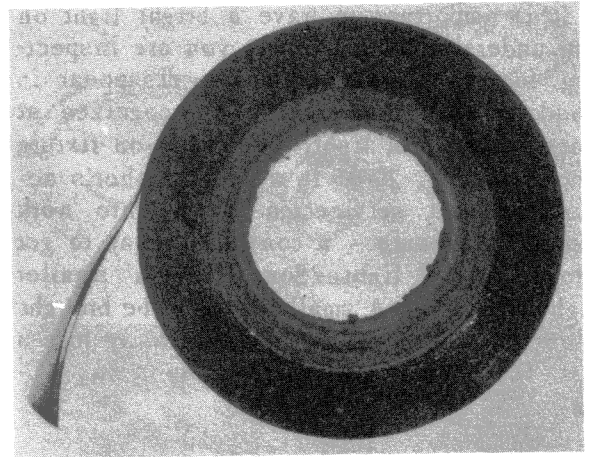


Fig. 20-55

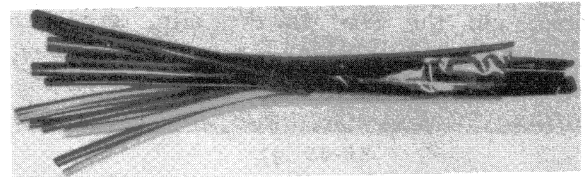


Fig. 20-56

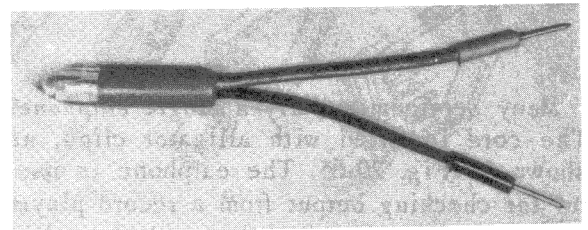


Fig. 20-58

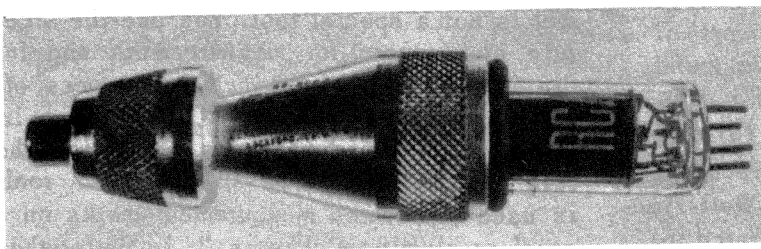


Fig. 20-59

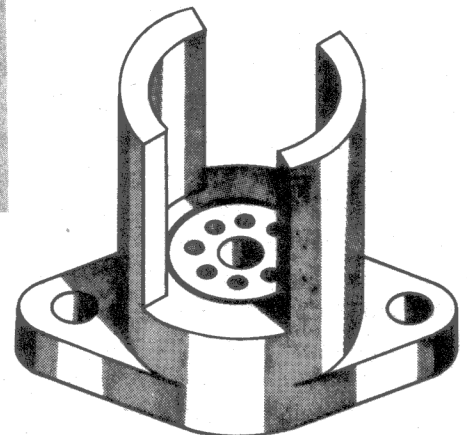


Fig. 20-60

It is important to have a bright light on the underside of a chassis you are inspecting for trouble. Defects that disappear in shadows and dim light are recognized at once in a bright light. The clamp-on fixture shown in Fig. 20-61 is a photographer's accessory that servicemen clamp onto work bench or chassis — a convenient way to get close bright light. Sometimes a smaller light is needed. A small light can be brought closer to your work and it fits easily into a tool box. One of these is shown in Fig. 20-62.

The *fuse clip* of Fig. 20-63 makes it unnecessary for you to solder when replacing a pig-tail fuse. You cut the pig-tails off a new fuse, put the fuse in the clip, and then clamp the whole thing over the old fuse, which is still mounted on its place in the wiring.

A bottle of *plastic glue* (Fig. 20-64) is needed to repair plastic mounting strips, coil forms, etc.

Many servicemen carry a single *earphone*. The cord is fitted with alligator clips, as shown in Fig. 20-65. The earphone is useful for checking output from a record player and for tracing the sound signal through a radio.

Test Leads and Clips. The serviceman is forever making temporary connections. For temporary connections you need a set of temporary clips and leads. You have found that your *alligator clips* are quite handy. Figure 20-66 shows the *alligator clip* (a) and two other clips that are similar: the *crocodile clip* (b) and the *Pee-Wee clip* (c). *Battery clips* come in large sizes, as illustrated in Fig. 20-66d. The *Wee-Pee-Wee clip* of Fig. 20-66e is a very small clip that is useful in tight spaces or wherever lead length must be short. When you want to temporarily connect a wire to a terminal lug, but the wire has no clip of its own, use the *Twin clip* shown in Fig. 20-66f. Clip it to the wire and clip it to the lug.

It is well to have a few *clip leads* of various lengths (Fig. 20-67) to use for connecting widely separated terminals. You can make these yourself by attaching an alligator clip on each end of a wire. The best wire to use is the kind used for meter leads. It is a fine braided wire with thick solid-rubber insulation. Ordinary hook-up wire does not last as well. Insulating sleeves (these are manufactured) can be slipped over the clips.

An *adapter cable* is a lead with a connector at each end. The connector on one end is a different kind than the connector on the other end. With an adapter cable, you can join two or more devices that have different kinds of terminal connectors; for example, two pieces of test equipment. A set of adapter cables is shown in Fig. 20-68.

One very useful adapter cable is the *a-c cord* with clips shown in Fig. 20-69. It is used to apply power to anything that doesn't have its own power cord; for example, a record player taken out of a console radio.

20-11. CHASSIS LAYOUT TOOLS

Suppose that you were going to construct a radio receiver starting with a blank metal chassis. Or, suppose that you were repairing a radio receiver and found it necessary to put in a new part that did not fit the original holes. In either case, you need certain tools for laying out the holes. Figure 20-70 shows the tools needed: steel rule and square, scribe, centerpunch, and hammer. The hammer is not a special tool. You use the steel rule and square for measurements and for drawing lines. The 12-inch rule comes off and can be used separately. To remove it, you loosen the thumbscrew and slide the rule out. The *scribe*, a sharp-pointed tool, is used to scratch measurement marks on a steel or aluminum chassis. It is better than a pencil because the line it makes is very thin compared with the thickness of a pencil line. A thin line helps you get the hole exactly where you want it. The *center-punch* is also a sharp pointed tool. However, it has a heavy-duty point that can be used to dent the metal face of a chassis. Place the point of the center-punch at the meeting of the

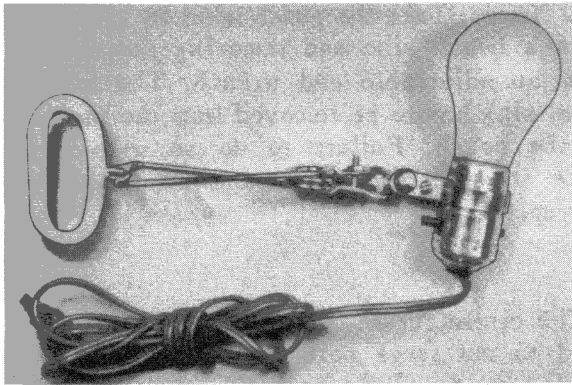


Fig. 20-61



Fig. 20-64

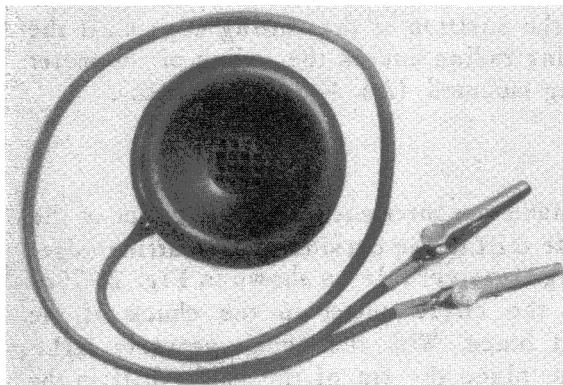


Fig. 20-65

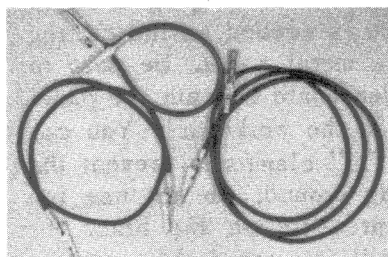


Fig. 20-67

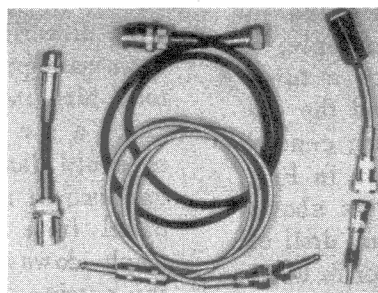


Fig. 20-68

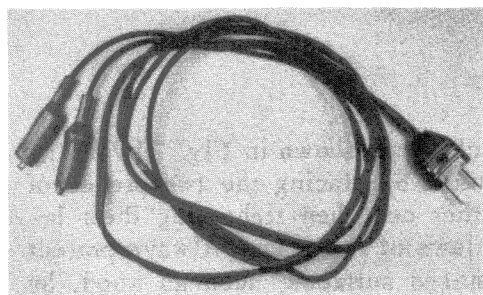


Fig. 20-69

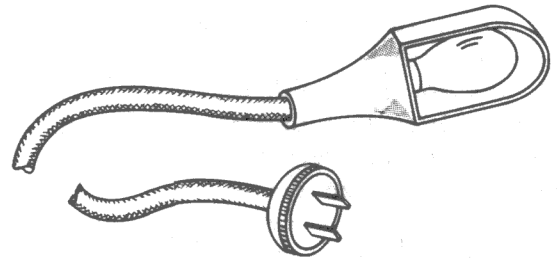


Fig. 20-62

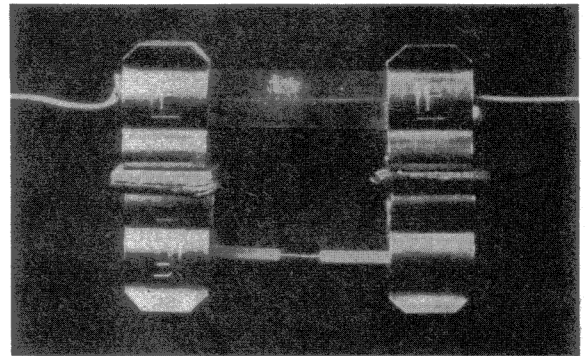


Fig. 20-63

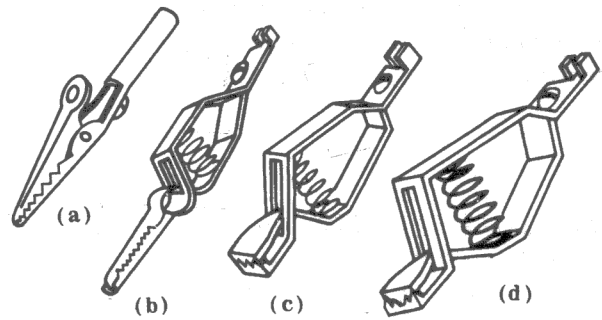


Fig. 20-66

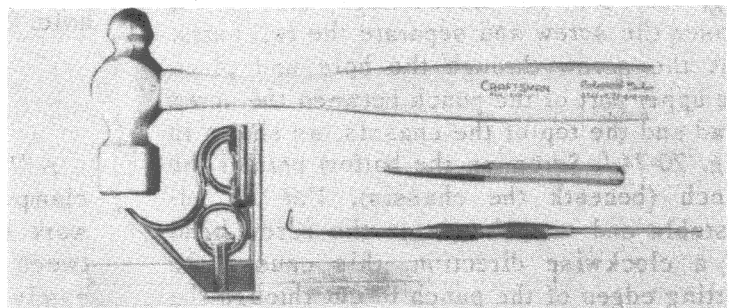


Fig. 20-70

scribe lines, as shown in Fig. 20-71. Hold the punch straight up-and-down. Strike the punch a sharp blow with the hammer. With thin metal, it is best to block up the under part with wood to prevent the chassis from caving in under the center-punch. Do not use the scribe as a center-punch. If you do, you will ruin the point and bend the scribe out of shape. Always hold the center-punch straight, as shown in Fig. 20-71, to prevent the point from sliding off the scribe mark when you hit it with the hammer.

Figure 20-72 shows a *vise* that is suitable for radio and TV repair work. It can be fastened to your workbench to hold work securely in place for drilling, filing, reaming, etc. The jaws of the vise scratch. To prevent this, place two pieces of wood between the jaws before clamping the work in place. Do not apply too much pressure when clamping radio and TV parts in the jaws of the vise.

Socket punches are used to make large holes in radio or TV chassis. A set of socket-punches is shown in Fig. 20-73. Radio and TV parts, such as sockets, switches, and electrolytic capacitors, can be mounted in holes these punches make. For example, a socket punch can be used to make a tube-socket hole in a chassis. First find the exact center position of the hole; then center-punch a mark at this point as shown in Fig. 20-74a. Next, drill a $\frac{1}{4}$ -inch hole as shown in Fig. 20-74b, using either the hand drill or the electric drill. The tapered reamer is used to enlarge the hole to $\frac{3}{8}$ -inch, as shown in Fig. 20-74c. To disassemble the punch, loosen the screw and separate the two parts. Put the screw through the hole and place the upper part of the punch between the screw head and the top of the chassis, as shown in Fig. 20-74d. Screw on the bottom part of the punch (beneath the chassis). Use an adjustable end wrench to turn the screw head in a clockwise direction; this causes the cutting edges of the punch to cut through the chassis. When the punch gets through, a clean, round hole will be made, as shown in

Fig. 20-74e. Take the punch apart by gripping it in a bench vise and removing the screw with an adjustable end wrench. The round metal slug has to be removed from the inside of the punch. Failure to do so will only make it more difficult to remove as slugs pile up.

The circle cutter, shown in Fig. 20-75a, is used to cut large holes, such as the hole needed to mount a meter on a front panel. Holes from $\frac{7}{16}$ inch to 3 inches in diameter can be made. To cut a 2.5-inch hole for mounting a meter, place a center punch mark where the center of the hole is to be, as shown in Fig. 20-75b. Drill a small guide hole at the center punch mark. Adjust the circle cutter to its correct cutting size by loosening the adjustment screw and adjusting the position of the cutting edge until the cutting radius equals the radius of the meter being mounted ($2.5 \div 2 = 1.25$ inch).

Make measurements from the center of the guide drill to the outside of the cutting edge, using the steel rule as shown in Fig. 20-75c. Put the circle cutter in the chuck of the hand brace. With the chuck securely tightened, place the tip of the guide drill in the hole and turn the brace slowly in a clockwise direction. Keep the tool upright. Slight downward pressure is needed as the cutting tool bits into the metal panel. Be sure to place a flat wooden board beneath the panel to avoid damage to the workbench. You can use two or more "C" clamps to prevent the panel from moving around. Do not use too much downward pressure on the brace, or the cutting tool will bite too deeply into the metal and make it difficult to cut out the hole.

A "C" clamp is shown in Fig. 20-76. The clamp is used by placing the two pieces of work together and then tightening them between the jaws of the clamp. Always protect easily damaged surfaces, such as wood, by placing a piece of cardboard between jaws and the surfaces that they touch.

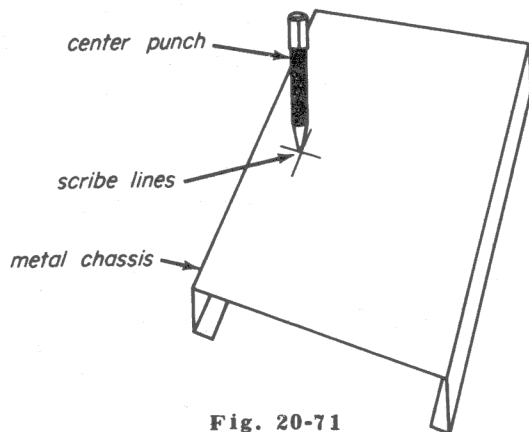


Fig. 20-71

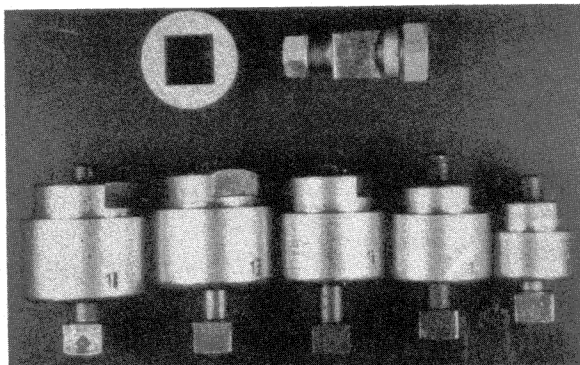


Fig. 20-73

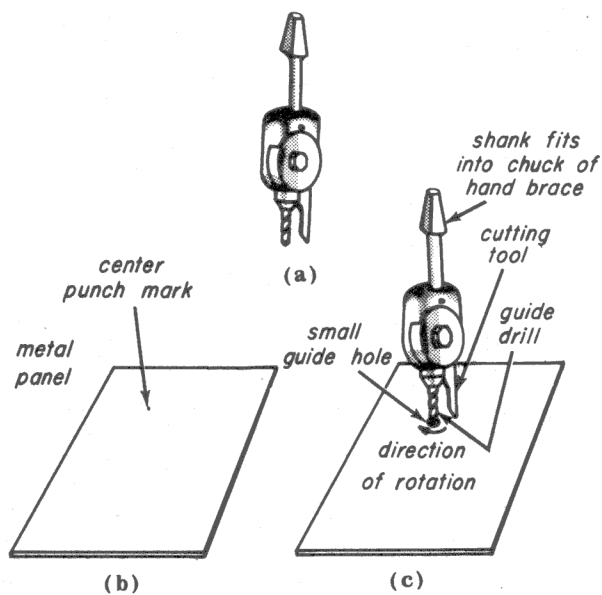


Fig. 20-75

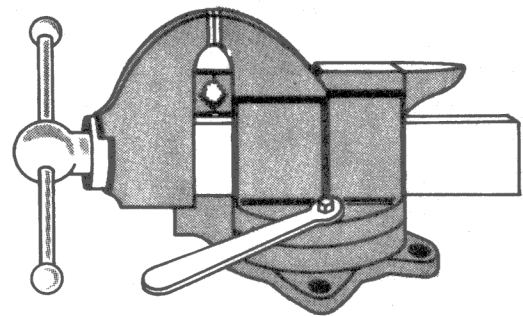


Fig. 20-72

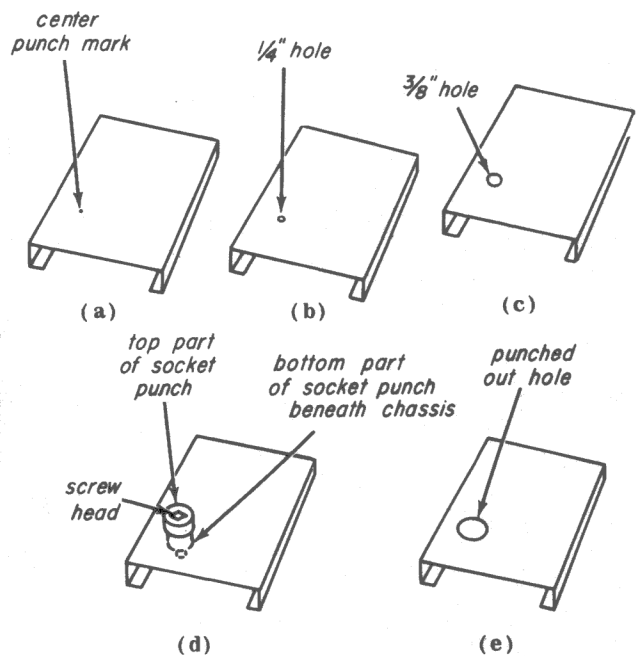


Fig. 20-74

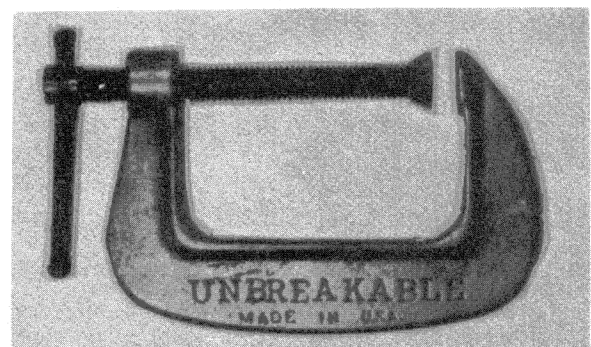


Fig. 20-76